11819

22315

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions : *(1)* ***All*** *questions are* ***compulsory****.*
(2) Answer ***each*** *next main question on a* ***new*** *page.*
(3) Illustrate your answers with ***neat*** *sketches* ***wherever*** *necessary.*
(4) Figures to the ***right*** *indicate* ***full*** *marks.*
(5) Assume suitable data, if ***necessary****.*
(6) Use of Non-programmable Electronic Pocket Calculator is ***permissible****.*
(7) Mobile Phone, Pager and any other Electronic Communication devices are ***not permissible*** *in Examination Hall.*

Marks

1. Attempt **any five** of the following : **(2×5=10)**

a) Write any three units of temperature.

b) Write Van der Waal's equation and give meaning of terms involved in it.

c) Define steady state and unsteady state operation.

d) Write the stoichiometric coefficient for the given reaction :

$4FeS_2 + 11\ O_2 \rightarrow 2Fe_2O_3 + 8SO_2$

e) Define NCV and GCV.

f) List out the different forms of energy.

g) Convert 3 atm into kPa and mmHg.

2. Attempt **any three** of the following : **(4×3=12)**

a) Write the SI unit of energy, power, heat and work.

b) A gas contained in a closed vessel at a pressure of 121.59 kPag and 299 K is heated to a temperature of 1000°C. Find the pressure to which a closed vessel should be designed.

c) The ground nut seeds containing 45% oil and 45 % solids are fed to an expeller, the cake coming out of expeller is found to contain 80% solids and 5% oil. Find the % recovery of oil.

d) Ethylene oxide is produced by oxidation of ethylene. 100 kmol of ethylene are fed to reactor and the product is found to contain 80 kmol ethylene oxide and 10 kmol CO_2. Calculate :

a) % conversion of ethylene

b) % yield of ethylene oxide.

P.T.O.

Marks

3. Attempt **any three** of the following : **(4×3=12)**

a) A sample of dry flue gas has the following composition by volume $\Rightarrow$ CO_2 = 13.4%, N_2 = 80.5%; O_2 = 6.1%. Find the % excess air supplied assuming that the fuel contained no nitrogen the N_2 and O_2 in the flue gas must have come from air.

b) A stream of CO_2 flowing at a rate of 100 kmol/min. is heated from 298 K to 383 K. Calculate the heat that must be transferred using Cp°.

Data : $Cp° = a + bT + cT^2 + dT^3$ KJ/(kmol.K)

Gas	a	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
CO_2	21.3655	64.2841	– 41.0506	9.7999

c) Describe recycle and bypass operation with neat diagram.

d) Calculate the density of air containing 21% O_2 79% N_2 by volume at 503 K and 1519.875 kPa.

4. Attempt **any three** of the following : **(4×3=12)**

a) Calculate the standard heat of reaction at 298 K of the following reaction :

Na_2CO_3 (s) + Fe_2O_3 (s) $\rightarrow$ $Na_2O.Fe_2O_3$(s) + CO_2 (g)

Component	$\Delta H°_{C,}$ kJ/mol at 298 k
Na_2CO_3	– 1130.68
Fe_2O_3	– 817.3
Na_2O - Fe_2O_3	– 1412.2
CO_2	– 393.51

b) A producer gas with the composition by volume 27% CO, 6% CO_2, 1% O_2 and 66% N_2 is burnt with 20% excess air. If the combustion is 98% complete. Calculate the composition by volume of the flue gases.

c) Describe the gas absorption operation with block diagram and material balance equation.

d) A feed containing 60 mole % A, 30 mole % B and 10 mole % inerts enters a reactor. The product stream leaving the reactor is found to contain 2 mole % A. Reaction taking place is 2A + B $\rightarrow$ C. Find the % of original A getting converted to C.

e) Calculate the heat required to raise the temperature of 100 kg water at 40° C to 90° C

Cp = 4.187 $\frac{KJ}{kgK}$.

Marks

5. Attempt **any two** of the following : **(6×2=12)**

a) Calculate the vapour pressure of pure butane at 20° C if its partial pressure is 698 mm Hg in a butane-acetone mixture. The mole fraction of acetone in the mixture is 0.577.

b) A waste acid from a nitrating process contains 23% HNO_3, 57% H_2SO_4 and 20% water by weight. This acid is to be concentrated to contain 27% HNO_3, 60% H_2SO_4 by the addition of concentrated H_2SO_4 containing 93% H_2SO_4 and conc. HNO_3 containing 90% HNO_3. Calculate the amounts in kg of waste and conc. acids that must be combined to obtain 1000 kg of desired mixture.

c) Gaseous benzene reacts with hydrogen in the presence of Ni catalyst as per the reaction :

$C_6H_6(g) + 3H_2(g) \rightarrow C_6H_{12}(g)$

30% excess H_2 is used above that required by the above reaction. Conversion is 50% and yield is 90%. Calculate the requirement of benzene and hydrogen gas for 100 moles of cyclohexane.

6. Attempt **any two** of the following : **(6×2=12)**

a) An evaporator is fed with 15000 kg/h of a solution containing 10% NaCl, 15% NaOH and rest water. In the operation, water is evaporated and NaCl is precipitated as crystals. The thick liquor leaving the evaporator contains 45% NaOH, 2% NaCl and rest water. Calculate :

a) kg/h water evaporated

b) kg/h salt precipitated

c) kg/h thick liquor.

b) A feed to a continuous fractionating column analyses by weight 28% benzene and 72% toluene. The analysis of the distillate shows 52 weight % benzene and 5 weight % benzene was found in the bottom product. Calculate the amount of distillate and bottom product per 1000 kg of feed per hour. Also calculate the % recovery of benzene.

c) In the production of SO_3, 100 kmol of SO_2 and 100 kmol of O_2 are fed to a reactor. If the % conversion of SO_2 is 80. Calculate the composition of the product stream on mole basis.